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ZINC ORES AT FRIEDENSVILLE, LEHIGH COUNTY, PENNA.

By

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Location.

The most important zinc deposits in Pennsylvania are at Friedensville, in the Saucon Valley, three miles south of Bethlehem. They have yielded large quantities of high grade zinc ore in the past and may be expected again to become an important factor in the zinc production of the country, although the mines are not operating now. Zinc ore has been found in paying quantity only in a very restricted area at and about ½ mile northwest from Friedensville.

History.

Early in the nineteenth century an unusual mineral was found in the soil on the farm of Jacob Ueberroth, ½ mile north of Friedensville, but it was not until 1845 that this strange mineral was identified as calamine, a silicate of zinc.

In October 1853 Samuel Wetherill completed the construction of furnaces for the production of zinc oxide from calamine by a process of his own invention. These furnaces at Bethlehem had a capacity of 2000 tons per annum and on October 13, 1853 zinc oxide was produced from the Friedensville ore on a commercial scale for the first time. This was the second successful attempt in the United States, the New Jersey Zinc Company having begun the manufacture of zinc oxide at Newark, New Jersey, in 1852.

The first spelter was produced in July 1859 at Bethlehem in the first entirely successful zinc furnaces in the United States. A mill

for rolling sheet zinc started operations in 1865.

From 1853 to 1876 the Lehigh Zinc Company operated its Friedensville mines without interruption and without local competition until 1875. The Bergen Point Zinc Company operated mines on adjoining property from 1875 to 1881.

In 1881 the Friedensville Zinc Company was organized and it operated the mines, with few interruptions, until November 1893, since which time the mines have all been idle. The New Jersey Zinc Company now owns all but one of the mines.

It is estimated that 50,000 tons of spelter and 90,000 tons of zinc oxide, valued at approximately $20,000,000, have been produced from the Friedensville zinc ores.

Character of the Ores.

The zinc ores first worked in the Friedensville region consisted almost entirely of calamine, together with some smithsonite mixed with the residual clay formed by the decomposition of the country rock which is Beekmantown limestone. With increasing depth of working the calamine and smithsonite decreased rapidly and zinc blende (sphalerite) intimately associated with pyrite and marcasite became more common.

The calamine was found in irregular segregations in the clay, in fissures in the limestone, or in the porous partially silicified limestone, often in botryoidal or stalactitic forms. Sheets or plates from 2 to 3 feet square and from one-eighth to one-fourth of an inch thick are said to have been frequently found in the crevices in the limestone.

The smithsonite was usually inconspicuous and occurred as white scales or granular masses coating the calamine or blende, or on the walls of the limestone fissures, or as yellowish-brown porous masses. The larger part of the smithsonite mined was amorphous and occurred in botryoidal, stalactitic, or laminated masses.

The Friedensville sphalerite or zinc blende is of a peculiar character, essentially unlike any other found in the country. In the main it occurs as compact gray to bluish black to black masses having a prominent conchoidal fracture and rarely showing any traces of crystallization. Much of it resembles dark blue limestone, from which it is readily distinguished, however, by its greater specific gravity.

Pyrite is almost universally found in association with the sphalerite in massive form. In many places the sulphide ore consists mainly of pyrite. The large amount of pyrite has been one of the most objectionable features of the sulphide ore.

Other minerals found in the Friedensville veins are marcasite,

melanterite, greenockite, goslarite, hydrozincite, sauconite, kaolin, quartz, calcite, aragonite, and limonite.

Ores of the Friedensville region are remarkably free from objectionable minerals such as those containing lead, arsenic and antimony, and for that reason the spelter and oxide made from them always commanded the highest price.

Occurrence of the Ores.

The Friedensville district is underlain by sharply folded and faulted Beekmantown limestone. Slickensided surfaces and fault breccia indicate displacements of the rocks. Such evidences of movement as can be obtained indicate that movement was principally along bedding planes.

The limestone was minutely shattered by the earth movements, a condition which permitted the active circulation of water and promoted mineralization of the area. The limestone strata and the main ore veins at the Ueberroth and Old Hartman mines on the north side of a fault are practically vertical, while at the New Hartman, Correll, and Three Corners mines the principal ore veins and enclosing limestones dip S 35°- 45°.

The more persistent ore veins are conformable with the bedding planes of the limestones and represent the filling of the openings between the different beds enlarged by solution, or, in places, the substitution of beds of considerable thickness by sphalerite and purite subsequently altered near the surface to calamine, smithsonite, and limonite. In places the veins were as much as 20 feet in width, although in the main only a few feet wide. They varied greatly in width even though they were continuous for great distances.

The veins following the joints are approximately at right-angles to the principal veins.

The ore bodies pitch along the strike to the southwest at an angle of about 20°.

The veins parallel to the limestone strata with a direction of N. 80°E. were remarkably persistent. The Stadiger vein in the Ueberroth mine was worked along the strike for a distance of about 1000 feet. On the other hand, the cross veins following the joints with an average strike of N. 10° W. were comparatively short. Where the two sets of veins intersected the ore bodies were largest and richest. Some of these masses of ore were as much as 60 by 20 feet in size.

The vertical extent of the ore bodies has not been determined, as ore was found in the greatest depth explored which was about 300 feet at the New Hartman mine.

Origin of the Ore.

The origin of the Friedensville zinc deposits is uncertain and there is a justifiable difference of opinion in the explanations offered by various geologists. The writer believes that the pre-Cambrian gneisses of southeastern Pennsylvania, most of which were igneous, carried pyrite and magnetite and some form of zinc minerals. Their disintegration furnished the material for the thick Paleozoic sediments of this region. In the long ages when Cambrian and Ordovician limestones were being deposited, the iron and zinc minerals must have been carried to the sea and precipitated in minute disseminated particles in the limestone as sulphides and carbonates.

While much of the iron and zinc may still exist as disseminations in the limestones, locally they have been concentrated through the action of circulating meteoric water. If descending water was the transporting agent the deposits would not extend much below ground water level. As the water table at present is within 30 feet of the surface and the ore deposits extend at least 300 feet deep, with every indication of continuing to greater depths, the conclusion seems warranted that ascending waters must have brought the sphalerite and pyrite to their present position. This conclusion is valid unless it can be shown that the ground water level formerly lay at much greater depth than now. Indications however are that the level of ground water has been continually falling as erosion has deepened the valley.

In the formation of the Friedensville zinc deposits it is believed that downward percolating waters containing carbonic acid derived from the atmosphere and organic matter, sulphuric acid derived from the oxidation of pyrite, and possibly some organic acids dissolved the small disseminated particles of zinc and iron carbonates and sulphides and carried them in solution to places where the water found an easy escape upward such as occurs in the shattered and faulted zones near Friedensville.

The pyrite and sphalerite were deposited in part in the fissures through which the solutions passed and in part as metasomatic replacements of the limestone. At the intersections of fissures through which solutions were passing the mingling of waters of somewhat different composition caused increased precipitation and resulted in the formation of the great masses of ore already described. Metasomatic replacement of the dolomitic limestones seems to have been much more important than precipitation in existing fissures. The dense black finely crystalline masses of sphalerite preserve the texture of the original limestone.

The deposits as originally formed consisted almost entirely of pyrite, marcasite and sphalerite. Calamine, smithsonite, limonite, greenockite and much of the quartz, calcite, and dolomite are all secondary and are the products of alteration by surficial waters.

Near the surface nearly all the sulphide ore was changed although some veins probably more compact and less permeable were altered to a depth of only a few feet. In the Ueberroth mine great masses of

calamine found at the greatest depths worked, about 225 feet, show an unusual depth of alteration. There is strong probability that some of the more permeable veins will yield oxidized ore at considerably greater depths.

Descriptions of Individual Mines.

Ueberroth Mine.

The Ueberroth mine was the largest and most profitable of all the Friedensville mines. Worked continuously from 1853 to 1876 and for short periods in 1886 and 1891 it produced about 300,000 tons of calamine and smithsonite ore. In no other mine in the region did the oxidized ore continue to such depths. To a depth of 150 feet the oxidized ores were found between loose blocks of limestone, some of enormous size. At that depth, however, the limestone became solid and the ore veins, 12 to 40 feet in width, had well-defined walls. The limestone strata and the main ore beds which lie between them are practically vertical in the Ueberroth mine with a strike about N. 80° E.

There were two very important veins in this mine known as the Stadiger and Trotter, both of which were worked continuously for a short distance along the strike of about 1000 feet. Another important ore body was known as the Blende vein. This vein was not worked so extensively on account of the larger amount of sulphide ore which it contained. At the deepest level worked this vein was well-developed and yielded ore running about 30% zinc. One-third of the ore was rich enough to be sent directly to the smelters, the remaining two-thirds, however, requiring concentration.

Several shafts were sunk at this mine but these have been destroyed by caving. At present the old open pit which is approximately circular and measures about 480 feet in diameter is filled with water to within about 30 feet from the surface. Nearly all the buildings which were formerly near the mine have been completely razed while the pumping engine house and office, the only ones remaining, are in ruins.

Old Hartman Mine.

About one-fourth mile southwest of the Ueberroth mine is the Old Hartman mine now consisting of two open pits about 400 by 250 feet in extent, both nearly filled with water. As in the case of the Ueberroth, the Old Hartman mine was first worked exclusively for calamine and smithsonite but large bodies of blende were encountered nearer the surface than in the Ueberroth mine. The oxidized ores were worked to the depth of 150 feet although much sulphide ore was found nearer the surface. The last work done in this mine was the driving of a slope to work a fine vein of sphalerite ore.

The limestones of the Old Hartman mine show much brecciation but are now less cavernous than in the Ueberroth mine. The water problem here was less serious than in the Ueberroth mine and the mine was operated for a year after the large engine at the Ueberroth pit was

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stopped. Had grouting been employed the necessary pumping might have been considerably reduced. At the present time the water level in the two openings is somewhat lower than in the Ueberroth pit which seems to show an independent source.

The Old Hartman mine was worked both by open cut and by shafts sunk in the limestones. The vein system is similar to that of the Ueberroth mine although no veins were followed for so great a distance. The veins of the two mines seem to be entirely distinct.

Correll Mine.

The Correll or Saucon mine is about one-eighth mile southeast of the Old Hartman mine. It was actively worked as early as 1859 and much of the time between that date and 1881 since which it has furnished little ore. The mine produced less oxidized ore in proportion to the sulphide ore than did the Ueberroth mine. The mine was worked by open cut up to 1876, after which underground mining predominated, and extended to a depth of 200 feet. The limestone strata and the principal ore veins which lie between them dip S 30° - 40°. The limestones are regular and show few effects of disturbance or of solution.

In 1876 a 12-foot vein of sulphide ore was being worked. In depth this increased to 40 feet and in one place to 50 feet. The whole length of working in the Correll mine was about 700 feet along the strike. The veins were worked to the western limits of the property of the Correll estate and are continued in the New Hartman mine.

The open pit of the Correll mine now partly filled with water measures approximately 200 x 300 feet.

New Hartman Mine.

The New Hartman mine adjoins the Correll property on the west. This is the only mine in the region that was exclusively worked by underground methods. The ore was struck in a vertical shaft at a depth of 110 feet and continued downward to a depth of 200 feet. Very little oxidized ore was found. When work ceased the principal ore vein was said to be 50 feet wide. Its strike was almost east and west and dipped S. 35°.

Three-Cornered Lot Mine.

This mine is east of the Friedensville-Colesville road a short distance northeast of the Friedensville Church. The open cut partly filled with water is irregular in shape with an average diameter of about 250 feet. Here as in most of the mines open-cut mining finally gave way to underground mining and several veins were followed which undoubtedly belong to the same system as those of the Correll and New Hartman mines and have the same general strike and dip. The limestone strata exposed dip S. 35° and strike N. 85° E.

Future of the Friedensville Mines.

A common belief exists that the Friedensville mines were closed on account of the exhaustion of the ore. This is incorrect as the ore bodies were as large in the lowest workings as near the surface, the veins giving no evidence of dying out with increased depth, and the sulphide ores showing little change in tenor. How much ore remains is purely a matter of conjecture but one can predict with a high degree of assurance that the mines will still furnish a large tonnage of sulphide ore as well as considerable calamine and smithsonite ore.

Another frequently-reported cause for closing the mines was the threatened litigation of the farmers whose wells were drained by the pumping required to keep the mines free of water. This explanation is likewise without foundation as the Courts have repeatedly upheld the principle that no mining company is liable for damages incurred by the withdrawal of water from previous users so long as this is necessary in order to remove the ore and the water is neither sold nor disposed of in such a manner as to damage other property.

The chief reason for the principal operating company, The Lehigh Zinc Company, closing its mines, which consisted of the Ueberroth, the Old Hartman, the New Hartman, and Three-Cornered Lot mines in 1876, was the inability to compete with the New Jersey Zinc Company in the manufacture of zinc oxide made from the zinc ores of Stirling Hill and Franklin Furnace, New Jersey, or with the companies operating in the Middle West in the production of spelter.

The present owners have not announced their intentions regarding these mines but it is probable that the mines will again become active producers.

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